Molecular-Scale Information Processing with Redox-Molecular Switches in Junctions

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Abstract:

Our brains constitute a molecular computer that is able to process enormous amounts of information with a tiny energy budget [1]. Inspired by the energy efficiency of brains and the ever-increasing demand for miniaturised electronics, there is a drive to develop devices that mimic the dynamic character of neurons and synapses [2]. To achieve this goal, brain-like computing is emulated with energy inefficient and complex silicon-based circuits or with mesoscale memristors, but these approaches still require large amounts of energy. For these reasons, it is important to develop new types of hardware that can mimic brain-like computation processes. In our group we develop electrically driven molecular switches that behave like synapses with the aim to realize spiking neural networks [3]. I will introduce a new type of molecular switch that can remember its switching history [4-6]. By coupling fast electron transport to slow proton addition steps via dynamic covalent bonds, the switches can switch in a time-dependent analogue manner like synapses and mimic basic spike-rate dependent plasticity, Pavlovian (associative) learning, 4-bit reservoir computing. These artificial synapses and oscillators are promising to develop alternative neural networks and open new ways to design molecular electronic devices by exploiting their inherent dynamical redox properties.

References:

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